Simulated Performance Analysis of Novel Automotive Spring-Starter Designs using Experimentally-Derived Dynamic Engine Modeling

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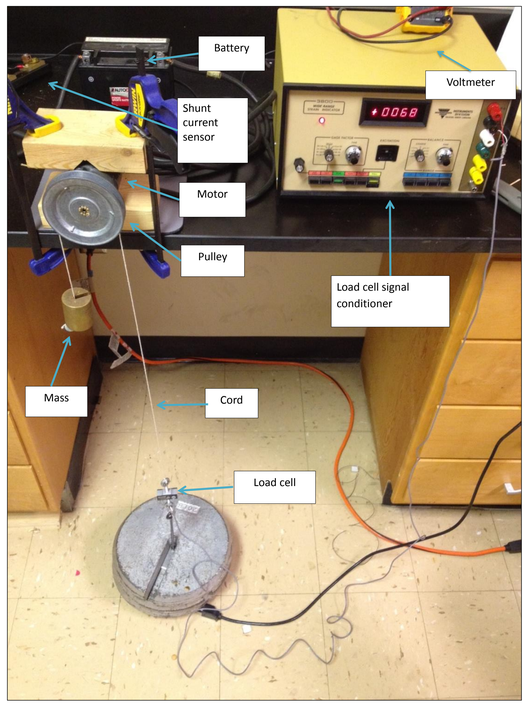
Motivation

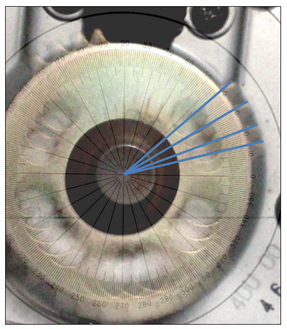
- Lead reduction
- Spring starters not available for autos
- Start/stop technology and hybrid vehicles
- Potential Advantages: Weight, efficiency, no jump-starting, inexpensive, environmentally benign



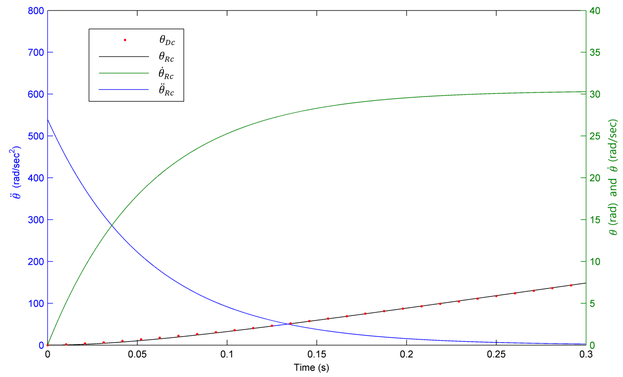
Starter Motor Testing

Methodology

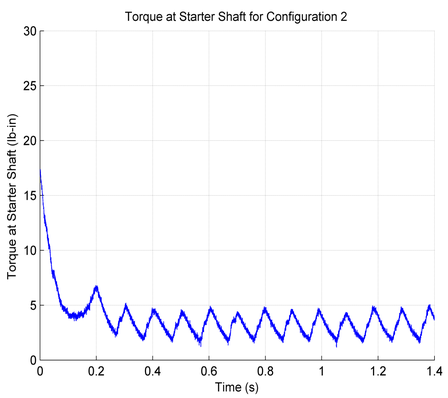
- Starter motor characterized by torque constant
- Motorcycle engine torque and crankshaft position measured while cranking
- Data used for model to characterize rotational mass of engine
- Optimization algorithm executed to determine ideal spring properties
- Engine response simulated for chosen springs in Simulink



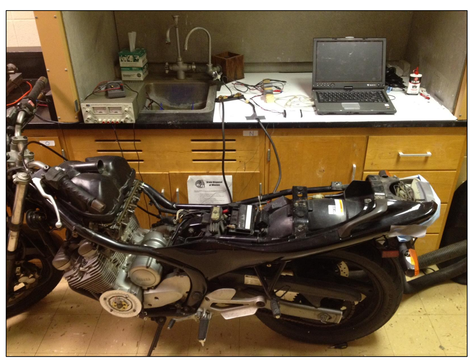
Position Measurement



Position Data and Regression Model



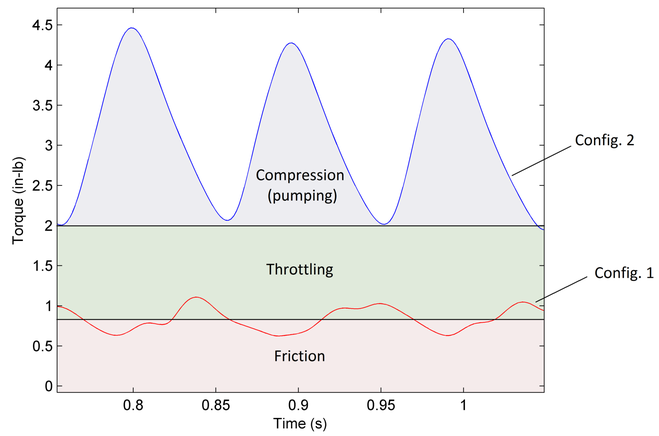
Torque Curve Showing Compression



Engine Experimentation Setup

Conclusions

- Springs of acceptable size and weight could start an IC engine
- Total number of revolutions is more important than time duration of cranking for engine starting



Starting Engine Torque by Component

$$T_c = J_c\ddot{\theta}_c + T_{pc}(\theta) + T_{fc} + T_{Tc}$$

Crankshaft Torque Equation

Future Direction

- Determine physical design of system
- Design and assemble prototype
- Review prototype design for marketability, manufacturability, expected cost